14. (Amended) The semiconductor device according to claim 13, wherein said another group-V element comprises at least one of As and P.

18. (Amended) The semiconductor device according to claim 13, wherein said semiconductor device comprises a self-pulsating semiconductor laser device.

REMARKS

The application has been reviewed in light of the Office Action dated January 28, 2002. Claims 1-18 are pending in this application, with claims 7-12 having been withdrawn from consideration. By the present Amendment, claims 1, 6 and 13, 14 and 18 have been amended. It is submitted that no new matter has been added and no new issues have been raised by the present Amendment.

Claims 1-6 and 13-18 were objected to under 37 C.F.R. §1.75 as allegedly being substantial duplicates. Without conceding the propriety of this objection, the claims have been amended in a manner which is believed to obviate this objection. Withdrawal of the objection under Section 1.75 is respectfully requested.

Claims 6 and 18 were objected to because of an informality. Without conceding the propriety of this objection, the claims have been amended to attend to this matter. Withdrawal of the objection to claims 6 and 18 is respectfully requested.

Claims 1-6 and 13-18 were rejected under 35 U.S.C. §103(a) as allegedly unpatentable over U.S. Patent 6,118,800 to Kidoguchi et al. in view of U.S. Patent 6,121,634 to Saito et al. Applicant has carefully considered the Examiner's comments and the cited art, and respectfully

submits independent claims 1 and 13 are patentable over the cited art, for at least the following reasons.

Independent claim 1 relates to a semiconductor device comprising a semiconductor substrate of a first conductivity type, a first cladding layer of the first conductivity type formed on the semiconductor substrate, an active layer formed on the first cladding layer, a second cladding layer of a second conductivity type formed on the active layer and a saturable absorbing layer formed on at least portions of at least one of the first cladding layer and the second cladding layer, wherein the saturable absorbing layer is formed to have a band gap energy either approximately the same as, or slightly smaller than, the active layer, and also to be doped with a high concentration of N.

Kidoguchi et al., as understood by Applicant, relates to a semiconductor laser and cleaving method. A saturable absorbing layer 1005 is formed on top of a first cladding layer 1004.

Saito et al., as understood by Applicant, relates to a Nitride semiconductor light emitting device which includes a multi-quantum well adjacent layer 104 made as a saturable absorptive region. In Saito et al., the group-V element of the III-V compound semiconductors used for the saturable absorber is always N.

In contrast, as described in the present disclosure, N can be used as a dopant for the III-V compound semiconductors used for the saturable absorber or used as a mixed crystal semiconductor in which N is used together with another group-V element such as As and P. Accordingly, the present disclosure is clearly distinguishable from Saito.

Irrelevant

Generally, in binary compound semiconductors the smaller the lattice constant, the

larger the bandgap energy. In mixed crystal semiconductors, the relationship between the lattice constant and bandgap energy is illustrated as a straight line. However, in the group-V element mixed crystal including N, the relationship is illustrated as a curved line. The degree of the curvature can be referred to as bowing. In a mixed crystal semiconductor in which N is used together with another group-V element such as As and P, a large bowing is present in the relationship between the band gap and lattice constant. Therefore, when N is added to a III-V compound semiconductor including As or P, a phenomenon occurs in which the lattice constant decreases and in addition the band gap also decreases if the amount of N added is small. The present disclosure utilizes this phenomenon. For example, by adding N to (Al)GaInP, it is possible to make the band gap of the saturable absorber smaller than that of the active layer.

In addition, mixed crystals of N with As or P have a strong nonmiscible property. Therefore, when the amount of N being added is increased, a number (or density) of nonradiative recombination states increases, resulting in shortage of the carrier life. Thereby, a life of a small number of carriers in the saturable absorber including N is shortened and it becomes possible to stably perform self-exited oscillation.

It is possible to perform the above-described operation by using a mixed crystal semiconductor including N and another group V element for the saturable absorber.

In contrast, in Saito, the group V element of the saturable absorber is always N (i.e., a mixed crystal of N with another group V element is not used). Accordingly, the problem to be solved by the present disclosure cannot be solved by Saito.

Accordingly, Applicant finds no teaching or suggestion of a semiconductor device

comprising a semiconductor substrate of a first conductivity type, a first cladding layer of the first conductivity type formed on the semiconductor substrate, an active layer formed on the first cladding layer, a second cladding layer of a second conductivity type formed on at least one of the active layer and a saturable absorbing layer formed on at least portions of the first cladding layer and the second cladding layer, wherein the saturable absorbing layer is formed to have a band gap energy either approximately the same as, or slightly smaller than, the active layer, and also to be doped with a high concentration of N, as recited in independent claim 1.

In addition, Applicant finds no teaching or suggestion of a semiconductor device comprising a semiconductor substrate of a first conductivity type, a first cladding layer of the first conductivity type formed on the semiconductor substrate, an active layer formed on the first cladding layer, a second cladding layer of a second conductivity type formed on the active layer and a saturable absorbing layer formed on at least portions of at least one of the first cladding layer and the second cladding layer, wherein the saturable absorbing layer is a mixed crystal of N with another group-V element and is formed to have a band gap energy either approximately the same as, or slightly smaller than, the active layer, as recited in independent claim 13.

Accordingly, Applicant submits independent claims 1 and 13 are patentable over the cited art.

The Office is hereby authorized to charge any additional fees that may be required in connection with this amendment and to credit any overpayment to our Deposit Account No. 03-3125.

If a petition for an extension of time is required to make this response timely, this paper should be considered to be such a petition, and the Commissioner is authorized to charge the requisite fees to our Deposit Account No. 03-3125.

If a telephone interview could advance the prosecution of this application, the Examiner is respectfully requested to call the undersigned attorney.

Entry of this amendment and allowance of this application are respectfully requested.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES IN THE CLAIMS

1. (Amended) A [self-pulsating] semiconductor [laser] device comprising:

a semiconductor substrate of a first conductivity type;

a first cladding layer of said first conductivity type formed on said semiconductor substrate;

an active layer formed on said first cladding layer;

a second cladding layer of a second conductivity type formed on said active layer; and

a saturable absorbing layer formed on at least portions of at least one of said first cladding layer and said second cladding layer,

wherein said saturable absorbing layer is formed to have a band gap energy either approximately the same as, or slightly smaller than, said active layer, and also to be doped with a high concentration of N.

6. (Amended) The [self-pulsating] semiconductor [laser] device according to claim 1, wherein said [self-pulsating] semiconductor [laser] device comprises a self-pulsating semiconductor laser device [is designed for use in an optical disk system].

13. (Amended) A semiconductor device comprising:

a semiconductor substrate of a first conductivity type;

a first cladding layer of said first conductivity type formed on said semiconductor substrate;

an active layer formed on said first cladding layer;

a second cladding layer of a second conductivity type formed on said active layer; and

a saturable absorbing layer formed on at least portions of at least one of said first cladding layer and said second cladding layer,

wherein said saturable absorbing layer is a mixed crystal of N with another group-V element and is formed to have a band gap energy either approximately the same as, or slightly smaller than, said active layer[, and also to be doped with a high concentration of N].

14. (Amended) The semiconductor device according to claim 13, wherein said [saturable absorbing layer comprises N as a] another group-V element comprises at least one of As and P.

18. (Amended) The semiconductor device according to claim [1] 13, wherein said semiconductor device comprises a self-pulsating semiconductor laser device [for use in an optical disk system].